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Proposal for Development of an Acoustic Beam Calibration Protocol for the Federal Interagency Sedimentation Project (FISP)

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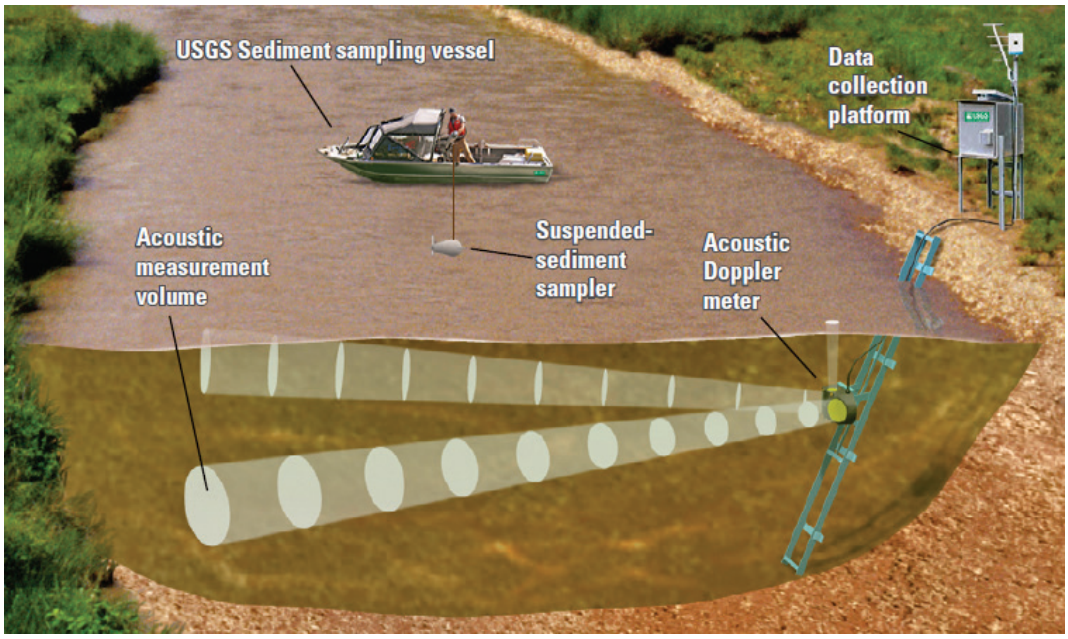

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Proposal Title

Development of an Acoustic Beam Calibration Protocol for the Federal Interagency Sedimentation Project (FISP)

Principal Investigator (PI)

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PI Contact Information

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Introduction and Background

Suspended sediment characteristics can be computed from backscatter intensity data collected by acoustic Doppler velocity meters (ADVMs), providing cost-effective time series data that cannot be readily collected by other methods. This data is essential for addressing many environmental, engineering and agricultural concerns.

The measurement of suspended sediment from acoustic backscatter is a complicated process, and is dependent upon the instrument used and conditions in the field. Research in this area has been ongoing for many years, and standardized methods are a comparatively recent development. It is expected that these techniques will continue to be revised and improved in the coming years.

The measurement of backscatter intensity is not the primary purpose of ADVMs, and the data from individual instruments is typically not precisely calibrated. The suspended sediment rating developed for each site is to some degree dependent on the individual instrument installed. If this instrument needs to be replaced because of malfunction, upgrade, or some other reason, the rating curve may need to be regenerated. This is costly and time consuming process, and can reduce the quantity and quality of data collected.

Purpose and Scope

The purpose of this proposal is to develop a protocol to calibrate the backscatter intensity data from ADVMs to allow the replacement of sensors without impacting suspended sediment data. ADVMs are available from multiple manufacturers, operate at a range of acoustic frequencies, and use different beam configurations. Additionally, sensors from individual manufacturers are periodically updated with new acoustic and electronic designs that may impact backscatter data.

This proposal aims to address instruments that are used for suspended sediment monitoring at this time. The most widely used instruments provide a horizontal profile of velocity and backscatter intensity across the width of a river or other body of water, and are commonly referred to as side-looking ADVMs. The calibration protocol will be designed to allow the exchange of instruments from the same manufacturer operating at the same acoustic frequency, without the need to update the index rating developed for a specific site. Future work may consider data from vertically profiling ADVMs, or from instruments operating at similar but not identical acoustic frequencies.

Technical Requirements

The goal of the project is to provide a method to calibrate acoustic backscatter data from individual side-looking ADVMs. This would be achieved through the following steps:

- Review existing ADVM sediment monitoring methodology to understand the range of instruments used, data analysis techniques, and challenges faced
- Work with ADVM manufacturers to evaluate available instruments, variations in data provided, as well as past and anticipated changes in instrument design
- Evaluate potential beam calibration methods including reference hydrophones, suspended sediment tanks, discrete acoustic targets, or in-situ use of reference instrumentation
- Review potential calibration facilities and instrumentation including ADVM manufacturers, existing government laboratories, and third party contractors
- Prepare a report summarizing the findings of the project; incorporate feedback and comments from all project participants

Deliverables

The deliverable would be a report describing a recommended protocol for calibrating side-looking ADVMs for suspended sediment monitoring. It would include the instrumentation covered, equipment required, recommended calibration facilities, and the anticipated accuracy of the calibration. It would also describe the data analysis required, and how the calibrated data could be applied to existing suspended sediment indexing procedures.

Timeline

The proposed project could be completed on the timeline shown below.

Task	Months after Receipt of Funds
Task 1: Review existing methodology	Months 1-2
Task 2: Manufacturer research	Months 1-2
Task 3: Analysis of calibration alternatives	Month 3
Task 4: Evaluate calibration facilities	Month 3
Task 5: Final report and discussion	Month 4-5

Budget

We propose to conduct this work on a time and materials basis; all labor would be billed at a standard rate of $180.00 per hour. No direct expenses or travel costs are anticipated.

The budget would be established as a not-to-exceed limit, beyond which no charges could be made without the client's approval.

Task	Hours	Task Total
Task 1: Review existing methodology	12	$2,160
Task 2: Manufacturer research	8	$1,440
Task 3: Analysis of calibration alternatives	16	$2,880
Task 4: Evaluate available facilities	8	$1,440
Task 5: Final report and discussion	16	$2,880
Project Total	**60**	**$10,800**

PI Qualifications

The Principal Investigator, Craig Huhta, has spent his 25+ year career designing and operating specialized instrumentation for the measurement of water. He has designed some of the most successful hydrology instruments on the market including the FlowTracker, the Argonaut-SW, the SonTek-IQ, and portions of the RiverSurveyor ADCP. He has made measurements at sites from 3 cm to 5 km deep, and in locations around the world.

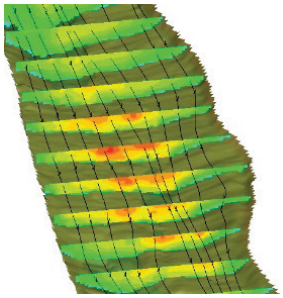
Craig understands how to operate these sophisticated instruments, and the technology behind the data. He works closely with hydrologists, scientists, engineers, and other water resource professionals. Craig takes the time to understand the goals of each application to be sure the data delivers what is needed.

The use of acoustic backscatter data for suspended sediment monitoring has been a regular and recurring application throughout his career. He has worked with universities, the U.S. Geological Survey, the U.S. Army Corps of Engineers, and other agencies to understand and evaluate this application on a variety of projects. Coupled with his intimate knowledge of the design of these instruments, he is uniquely qualified to successfully complete this project.

Professional Experience

OneFish Engineering, LLC, Co-Owner, Senior Engineer, 2013 to Present

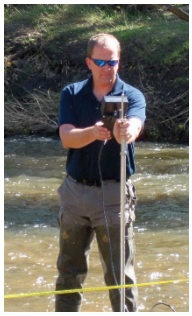





Craig provides engineering expertise in the fields of hydraulic measurement, data analysis, and modeling. Some of his projects include:

- Development of the WaterCube data analysis software which utilizes ADCP data in an entirely new fashion to provide detailed, 3D maps of topography and water velocity over large bodies of water
- Design and implementation of hydraulic and hydrological studies including instream flow and irrigation efficiency studies
- Design and installation of monitoring systems for hydraulic data and other parameters, including real time telemetry and remote data access
- Hydraulic modeling and data analysis

SonTek/YSI, Inc., Senior R&D Engineer, 1994 to 1998, 2001 to 2012



Craig led the design of acoustic instruments for the measurement of water depth, velocity and flow. His responsibilities included:

- New product development and support: acoustic systems, hydraulic measurement, modeling, firmware/software coding, user interface, data analysis, documentation, and field testing
- Direct responsibility for the design of new measurement firmware and data analysis techniques optimized for each application
    - Instruments included the FlowTracker, Argonaut-SL, Argonaut-SW, SonTek IQ, and the SmartPulseHD® measurement technology that provides un-matched velocity data quality from the RiverSurveyor ADCP
- Coordination of all aspects of product development including supervision of mechanical, electrical, and software engineers
- Extensive field data collection to evaluate and document instrument operation

United States Antarctic Program, 1999 to 2000

Craig managed and operated a variety of instruments in support of scientific experiments conducted from two research vessels operated in the waters around Antarctica. Measurements included water velocity, salinity, temperature, multi-beam sonar, and geomorphic bed profiling.

University of Hawaii, 1992 to 1994

Craig performed field work, developed data processing software, and managed data collection for ADCPs operating from research vessels working throughout the Pacific Ocean. The data collection includes measurements from vessel mounted ADCPs, and deployed ADCPs providing current profiles over the full depth of the ocean up to 5 km.